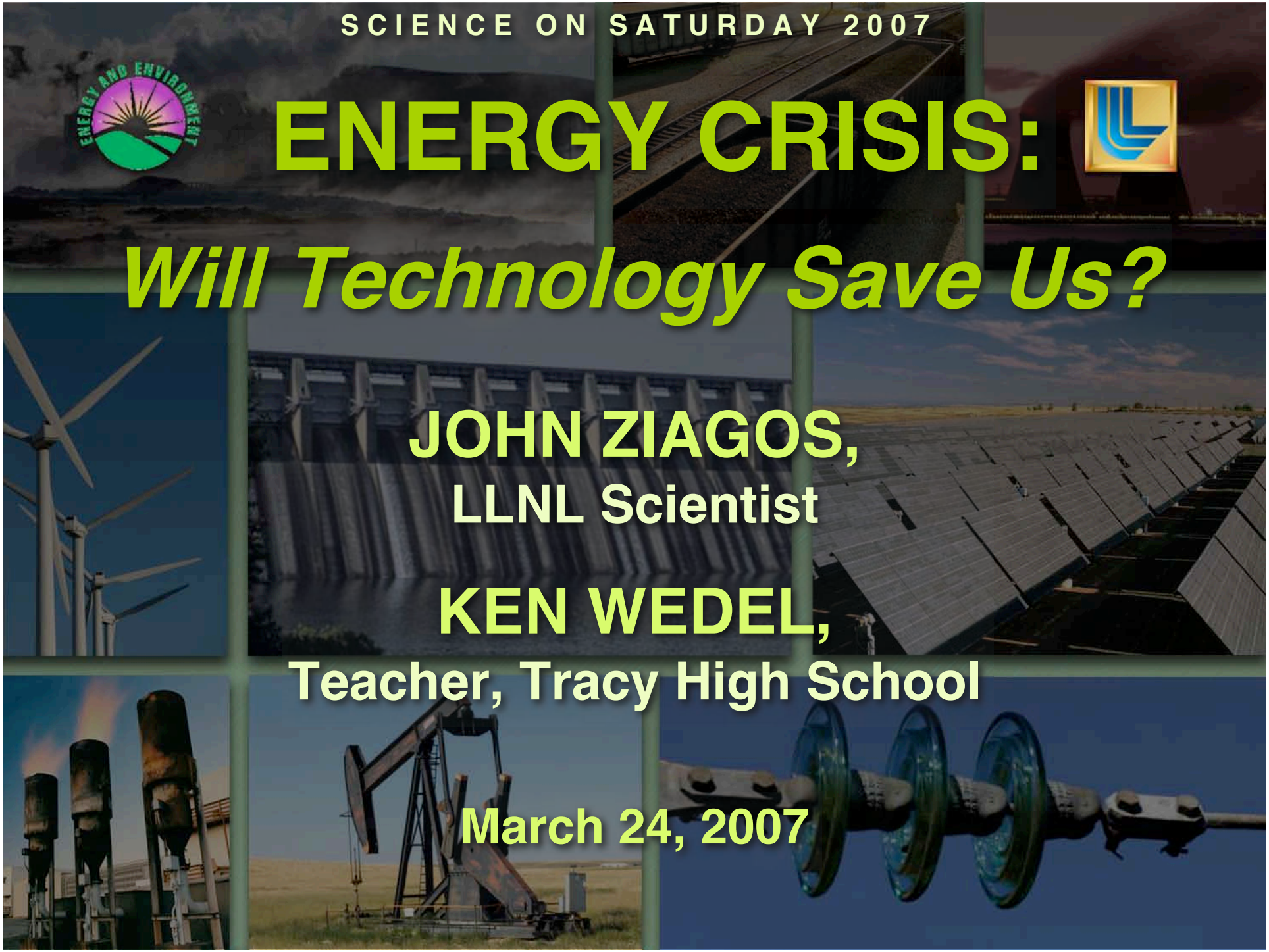

SCIENCE ON SATURDAY 2007
ENERGY AND ENVIRONMENT
ENERGY CRISIS:
Will Technology Save Us?
JOHN ZIAGOS,
LLNL Scientist
KEN WEDEL,
Teacher, Tracy High School
March 24, 2007

Energy Basics

ENERGY
Quick Overview

Energy
is a fundamental quantity in our universe

Energy
cannot be created or destroyed—
only converted

What is Energy?
"*the ability to do work*"

Only four forms of energy satisfy all our daily needs

Biochemical (carbohydrates, proteins in food)

Calories (cal)

Heat (wood, natural gas) for hot water, buildings and industry

Joules or British Thermal Units (Btu's)

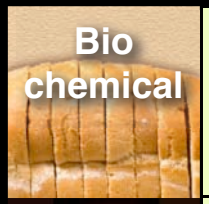
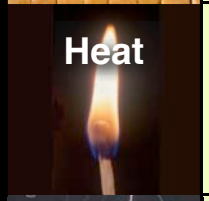
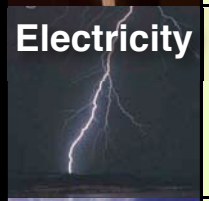
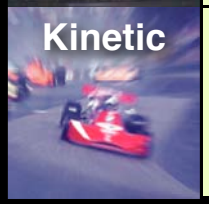
Electricity (light, appliances, refrigeration, heat)

Kilowatt-hours (kWh)

Kinetic (transportation of people and goods)

Gallons (gasoline) or barrels (oil)

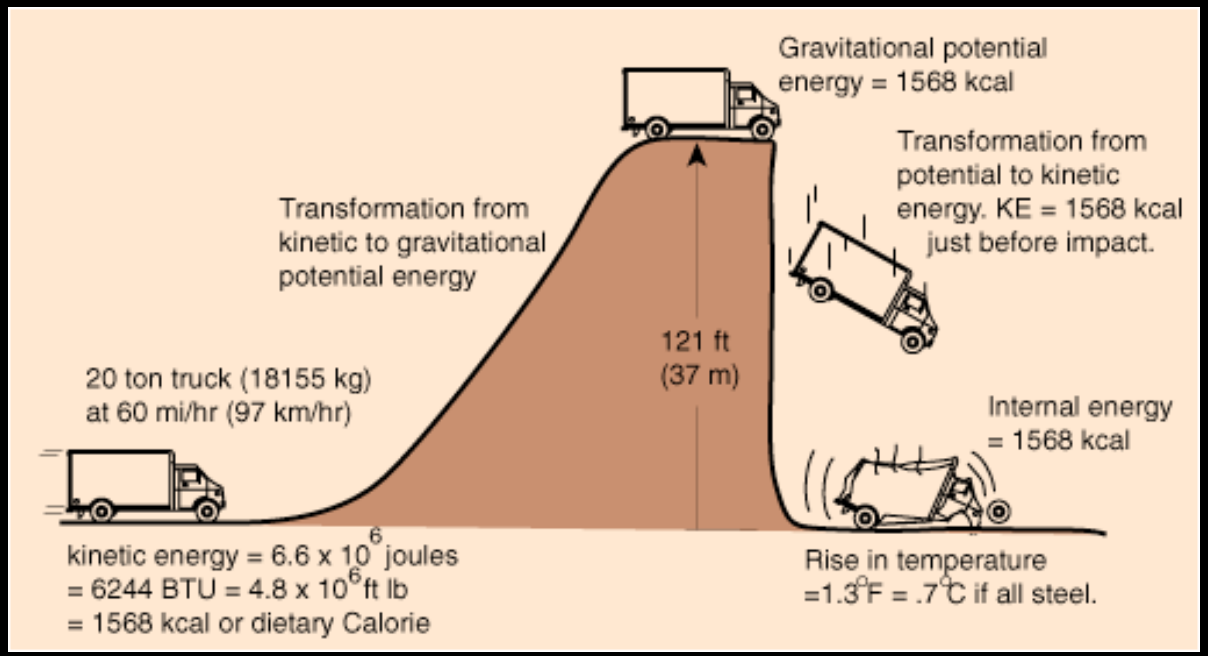
These four major forms have different: price, usage and yearly costs

	PRICE	USAGE	YEARLY COSTS
	$1.50/lb (1,000 cal of bread) $1.50/kWh	730 kWh	$1,000
	$10/M Btu of gas (~1000 ft^3) $0.03/kWh	14,650 kWh	$440
	$0.10/kWh electricity $0.10/kWh	13,600 kWh	$1,360
	$65/bbl (Oil) or $2/gal (gasoline) $0.05kWh	20,000 kWh	$1,200

There are nine major energy source types

Decreasing strength

Two major forms: potential kinetic



ENERGY CONVERSION DEMO

We divert many other chains of energy conversions for our uses

Hydro-electric

Gravity → Kinetic → Electricity

Internal Combustion Engine

Chemical → Thermal → Pressue → Kinetic

Lighting

Electricity → Radiation (light)

Just for FUN!

How many energy transfers?
How many energy conversions?

Answer: about 60 changes and 6 conversions

Is There An Energy Crisis?

An energy crisis is any great shortfall in the supply of energy

How much energy do we have?

How fast do we use energy?

Will we run out?

What about our environment?

Is There An Energy Crisis?

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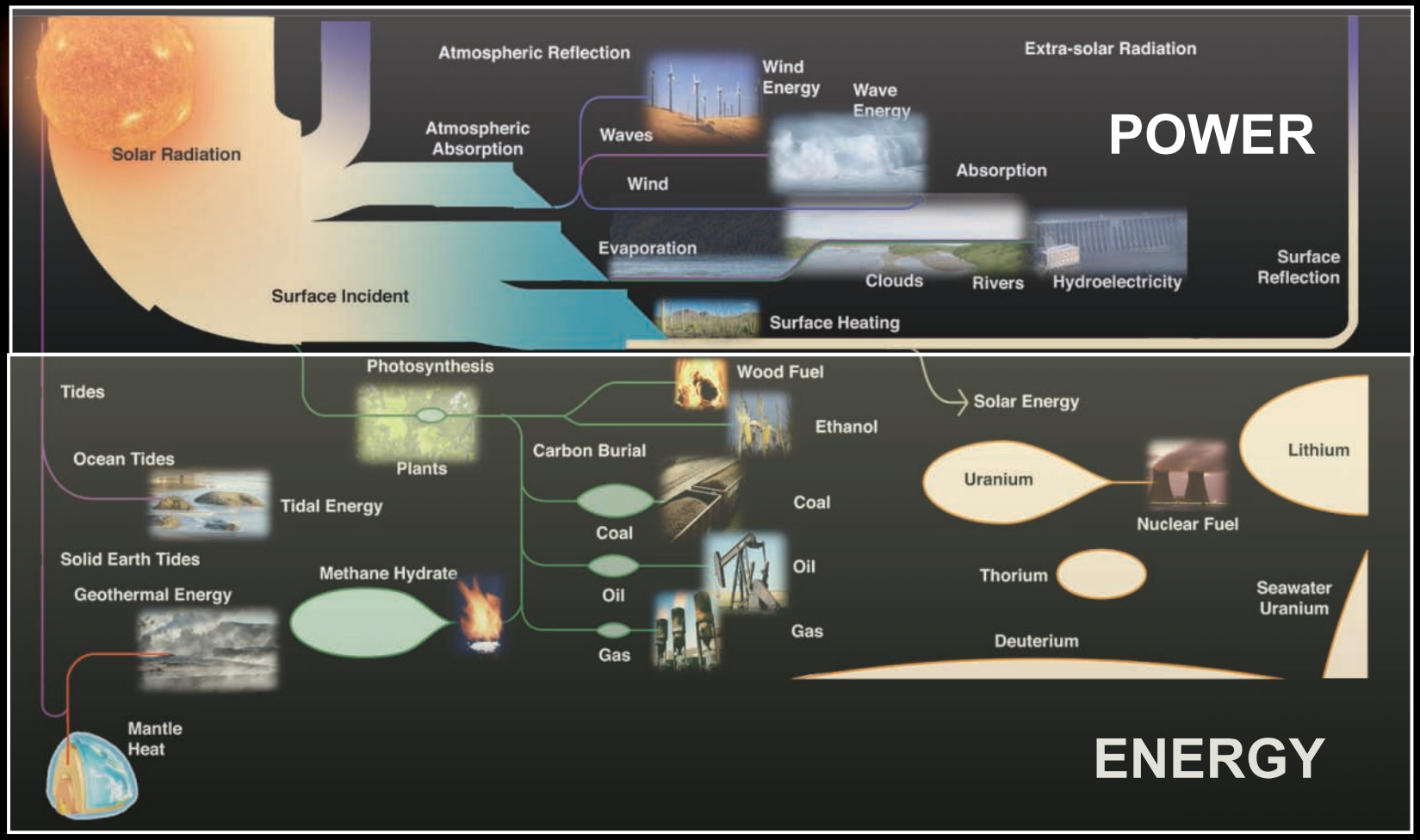
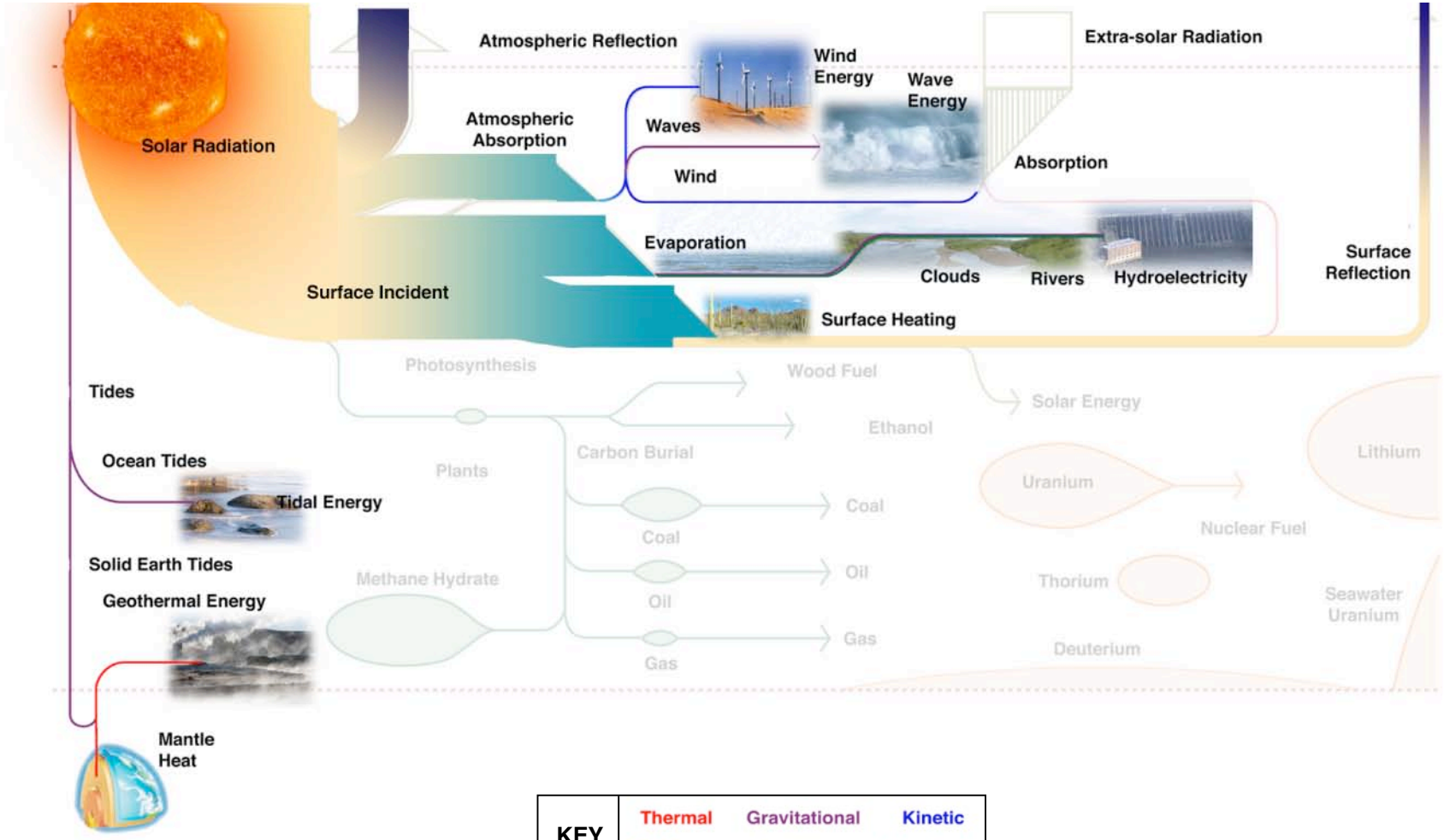
All of Our Energy Sources



THIS IS ALL THERE IS!

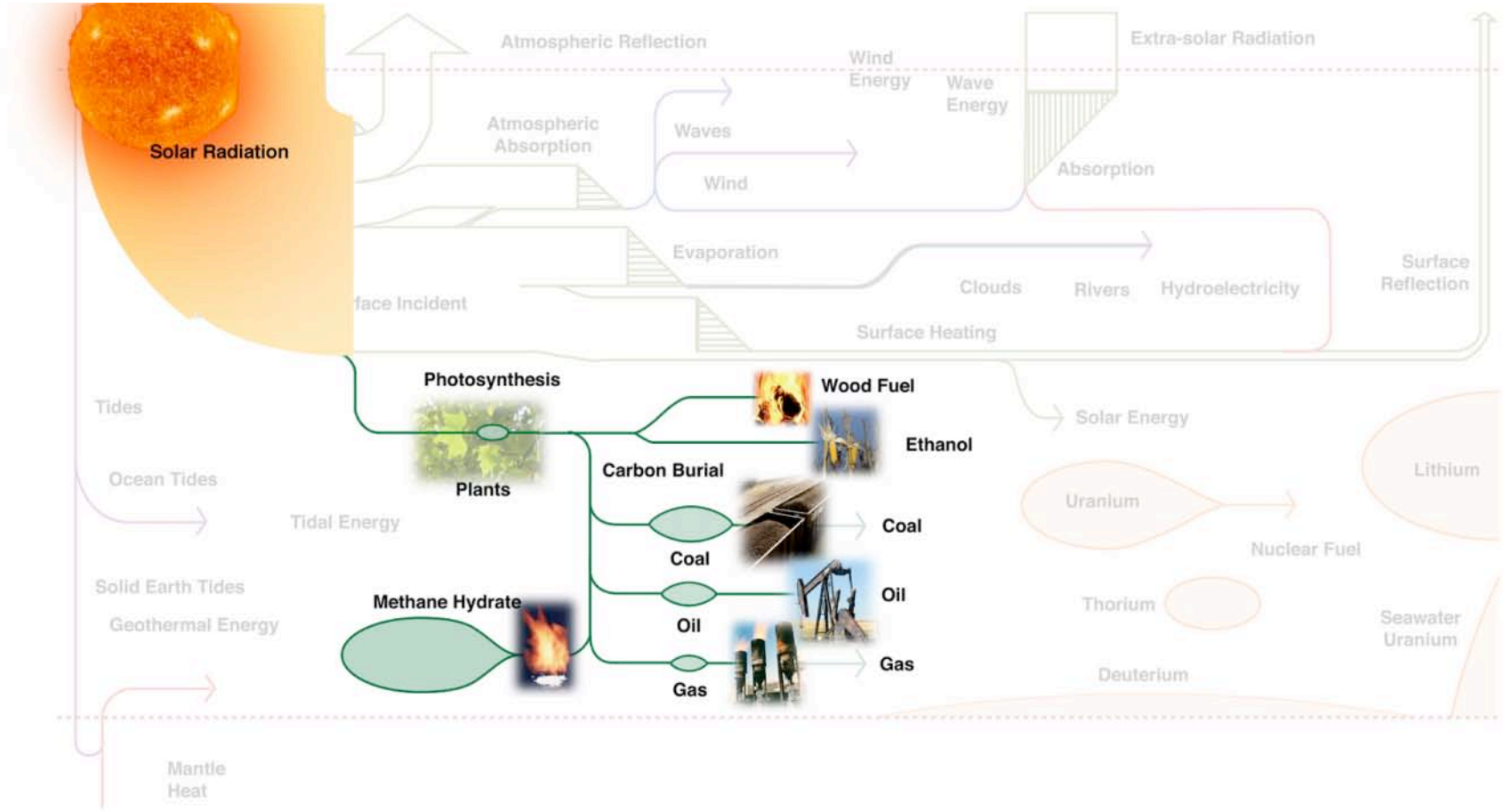
From Wes Hermann, 2005

The Sun Powers
All Our Renewable Energy



KEY	Thermal	Gravitational	Kinetic
	Nuclear	Radiation	Chemical

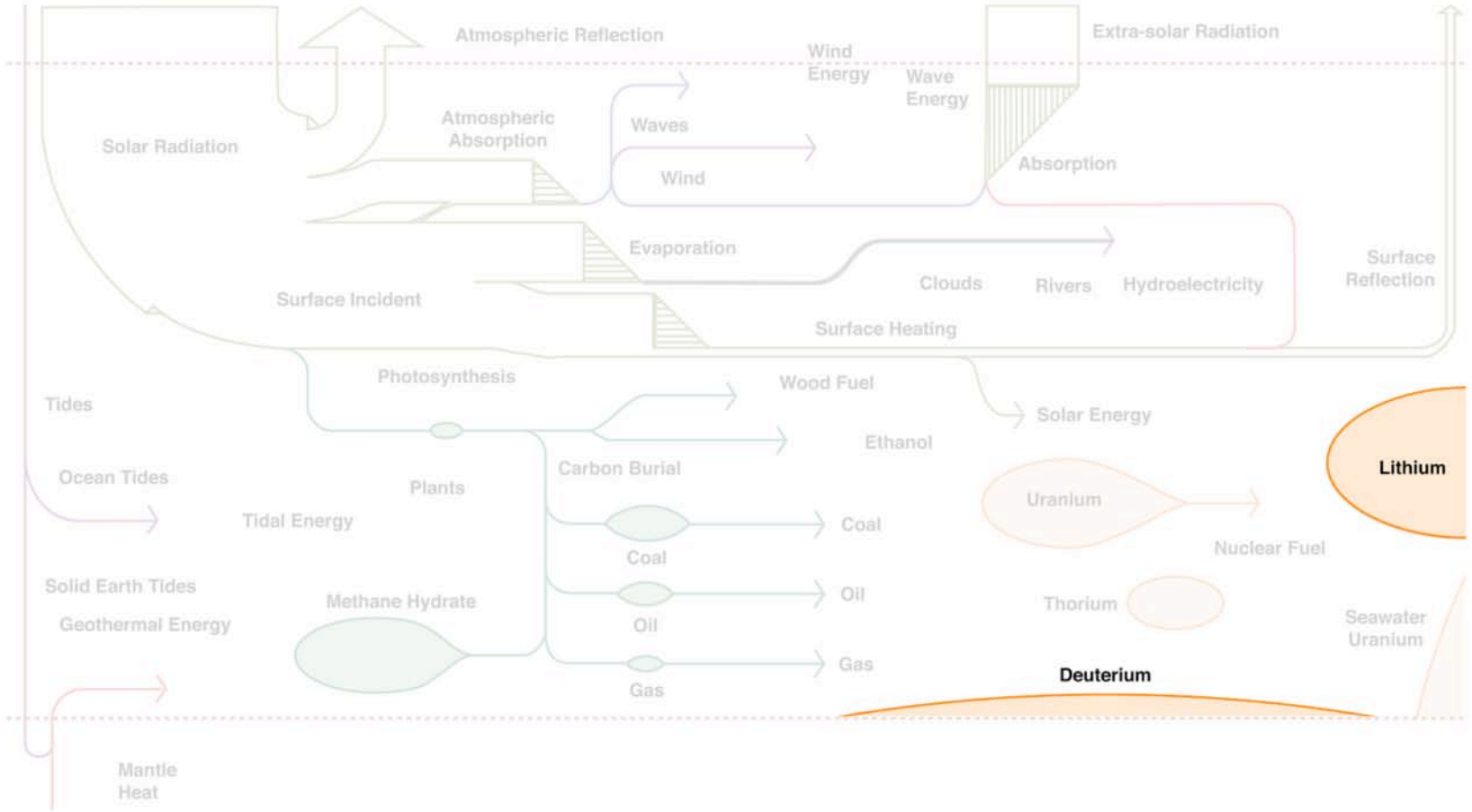
Fossil Fuels: Came From the Sun
We Are Using Them Up Quickly!



KEY	Thermal	Gravitational	Kinetic
	Nuclear	Radiation	Chemical

Nuclear Fuels Could Last a Very Long Time

Two kinds: fission and fusion



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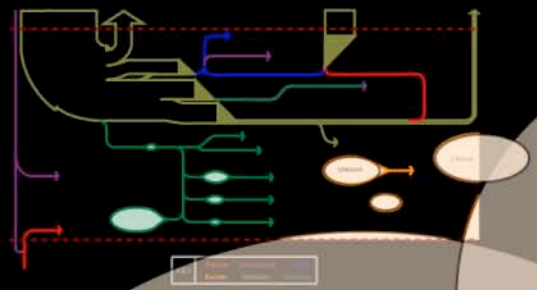


Fission Energy

Fusion Energy

Fission and Fusion are the Future!

Is There An Energy Crisis?

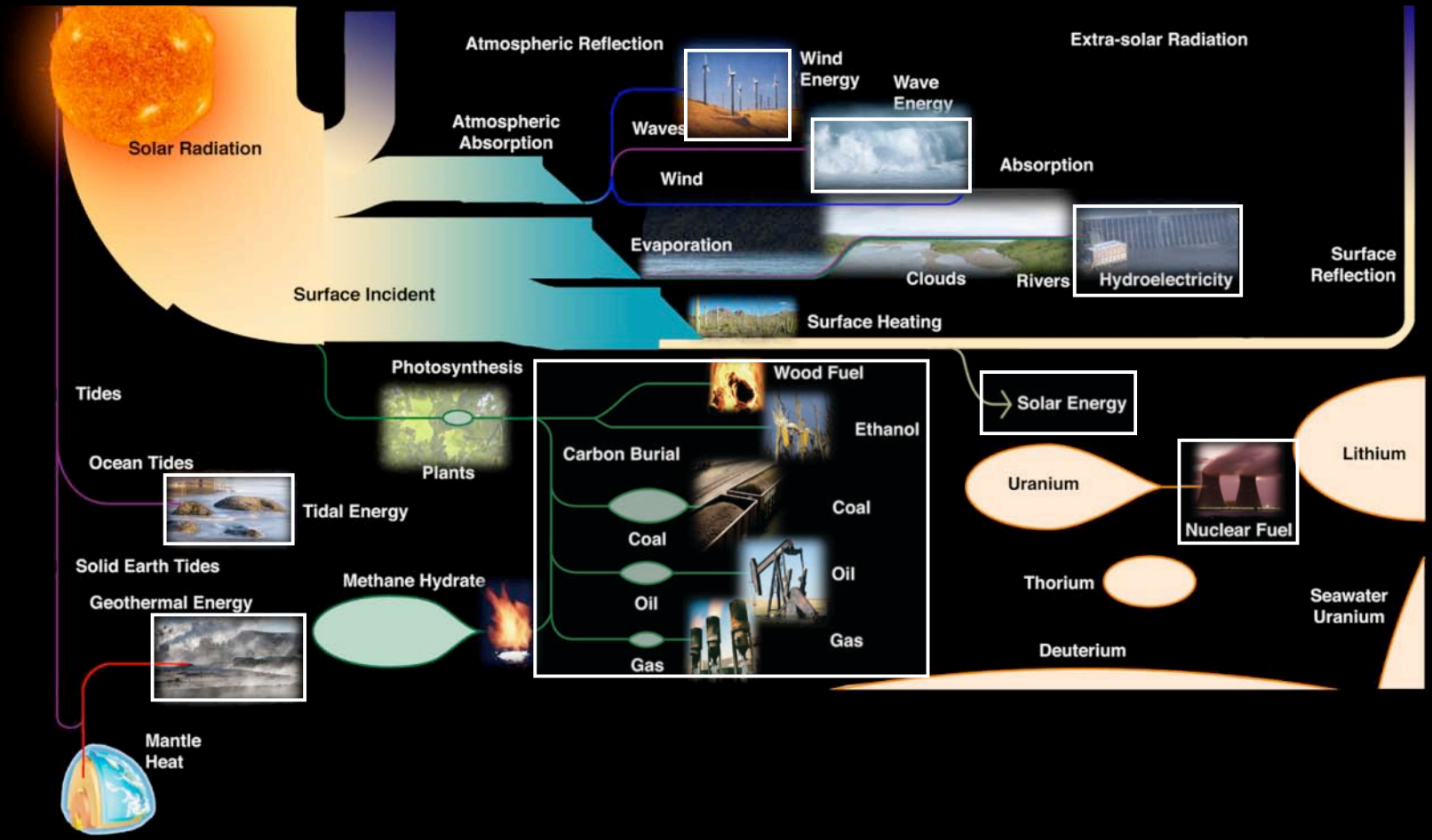
How much energy do we have?

How fast do we use energy?

Will we run out?

What about the environment?

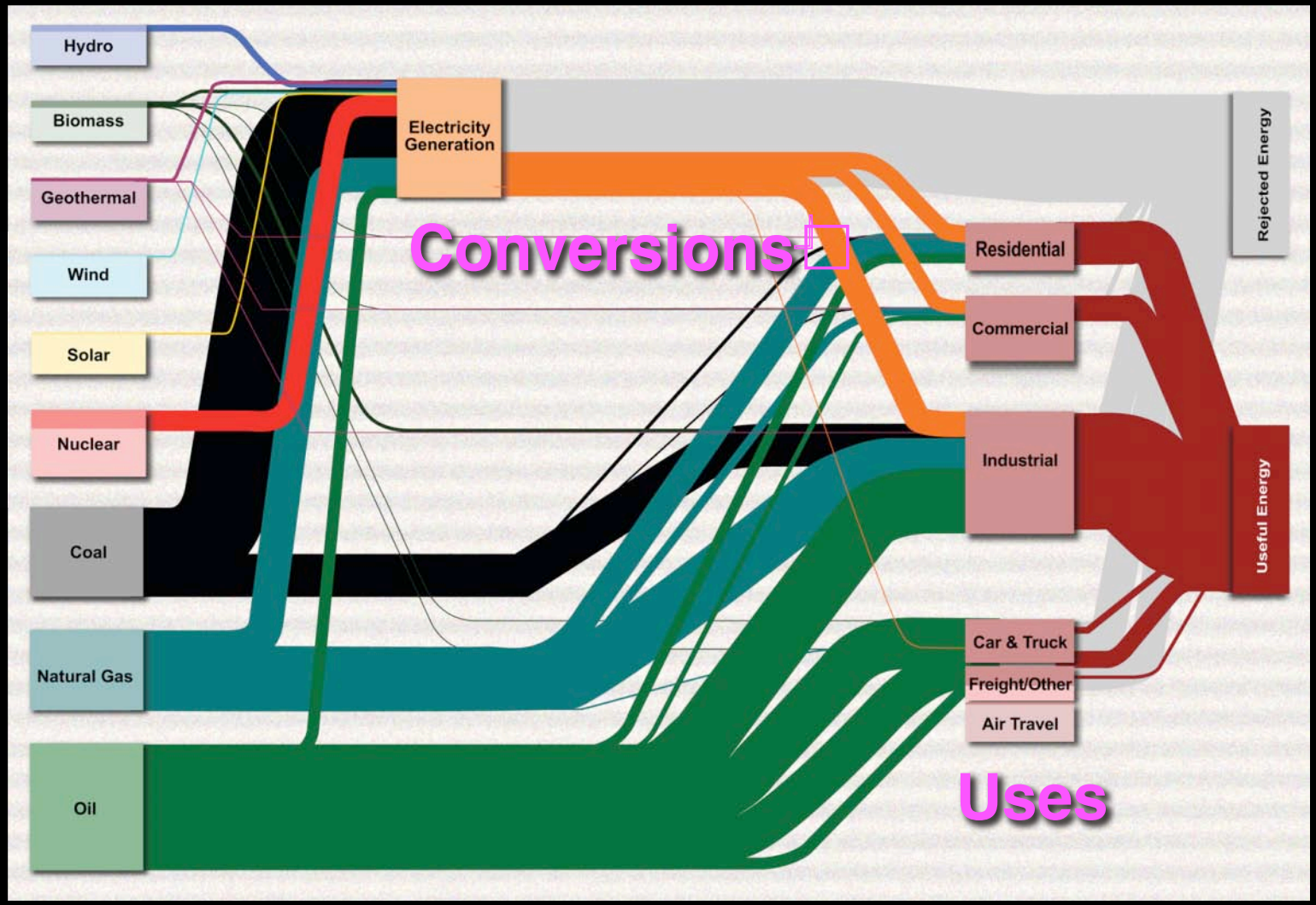
How Fast Do We Use Energy?



These are tiny energy flows, yet they…

…Power the World

World Energy Flow for 2005



Today, the world is using about 15 TW or 0.5 ZJ/year

Is There An Energy Crisis?

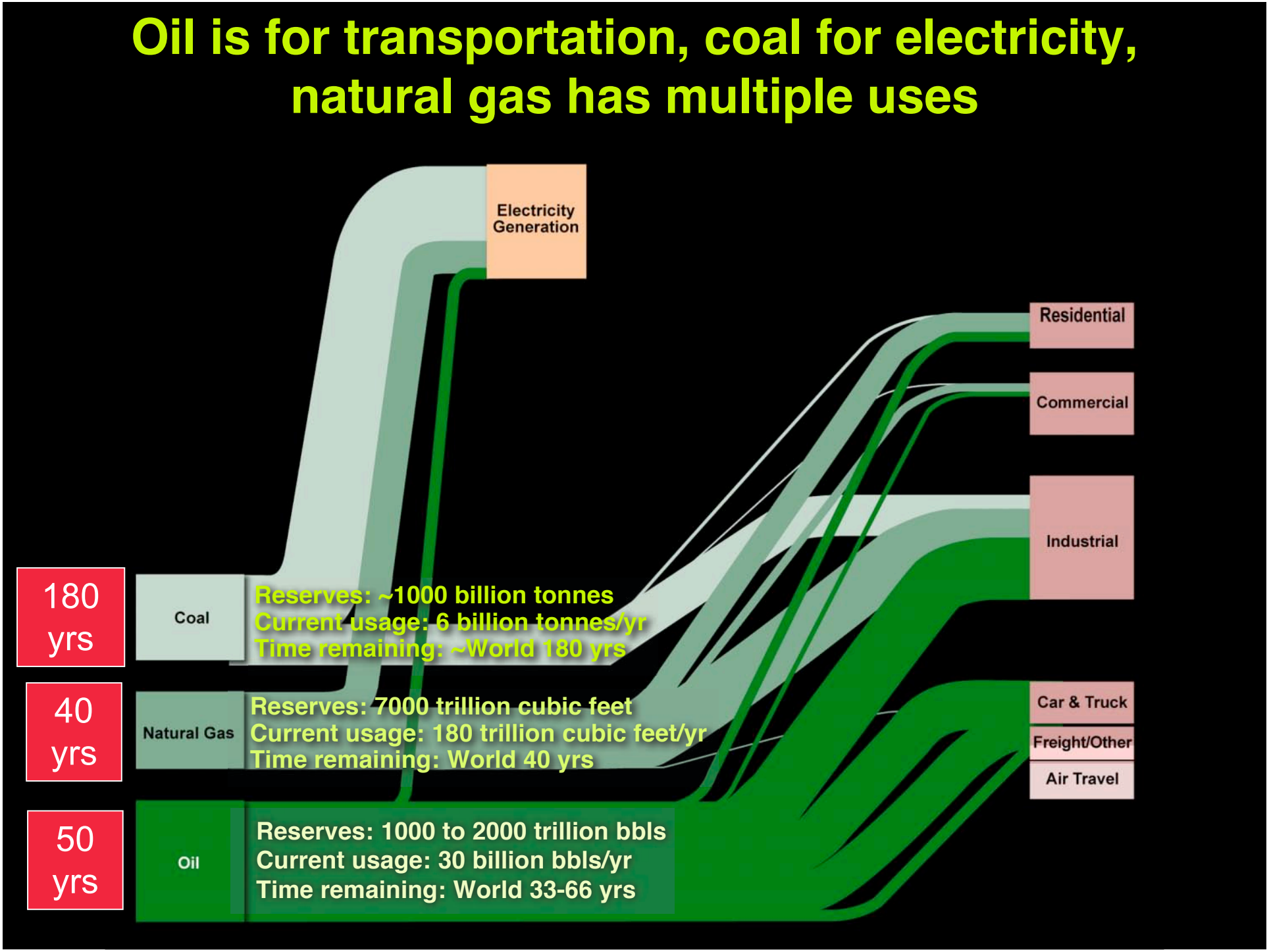
Three challenges:

1) Better harvest our sources

2) Improve efficiency

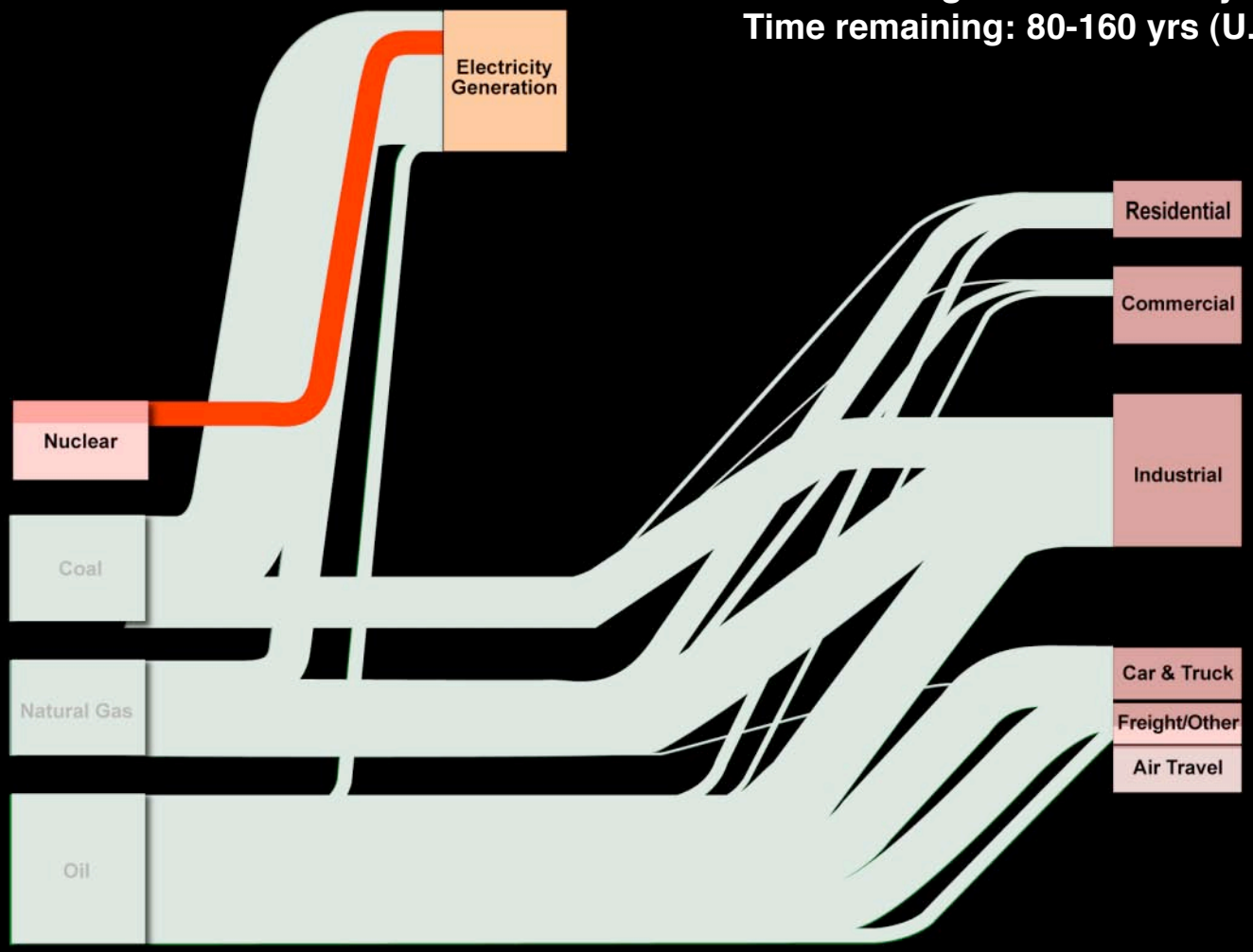
3) Lower energy costs

Oil is for transportation, coal for electricity, natural gas has multiple uses



Nuclear Fission is Today's Most Utilized Non-fossil Energy Source

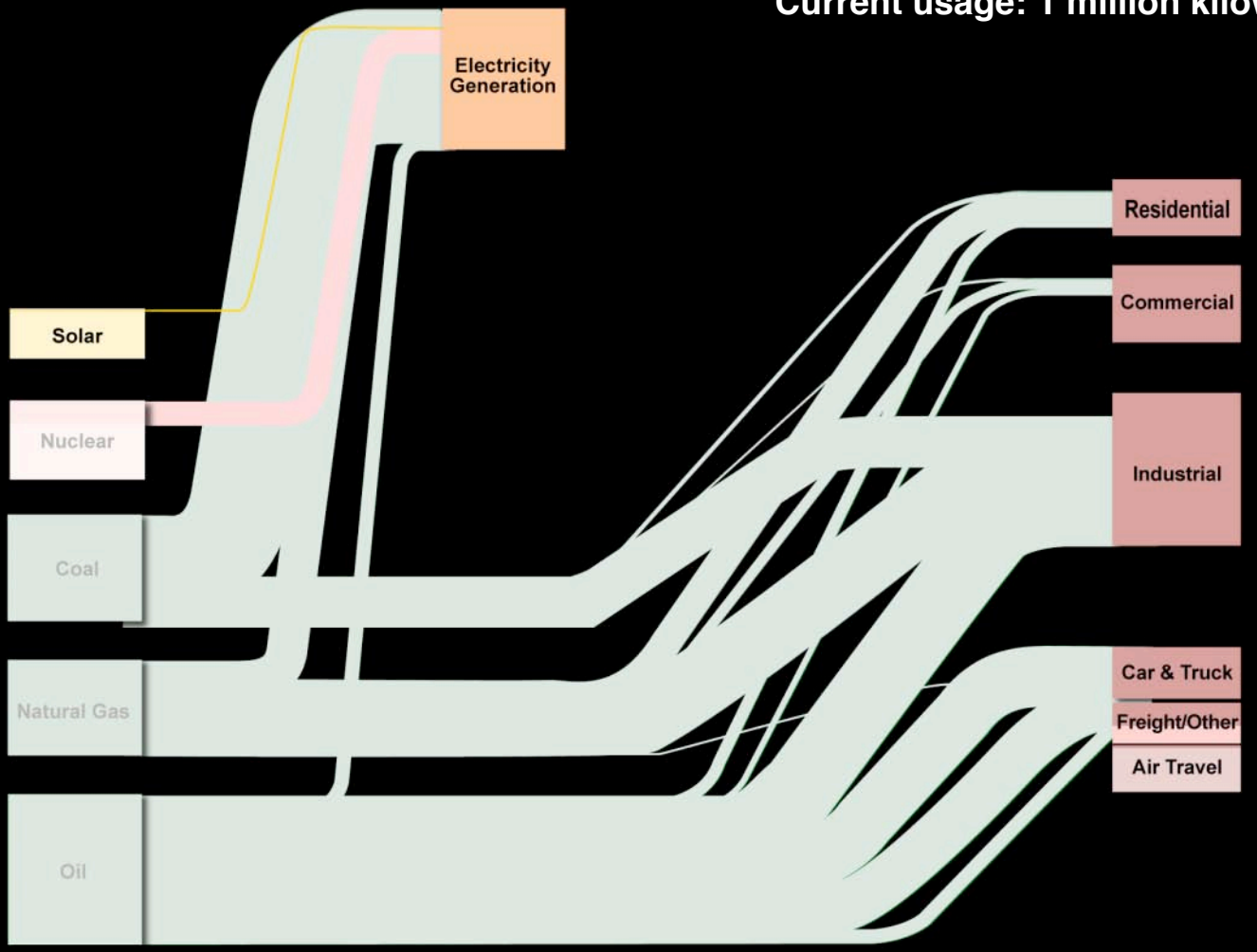
Reserves: 5-10 billion lb U_3O_8 (U.S.)
Current usage: 60 million lb/yr (U.S.)
Time remaining: 80-160 yrs (U.S.)



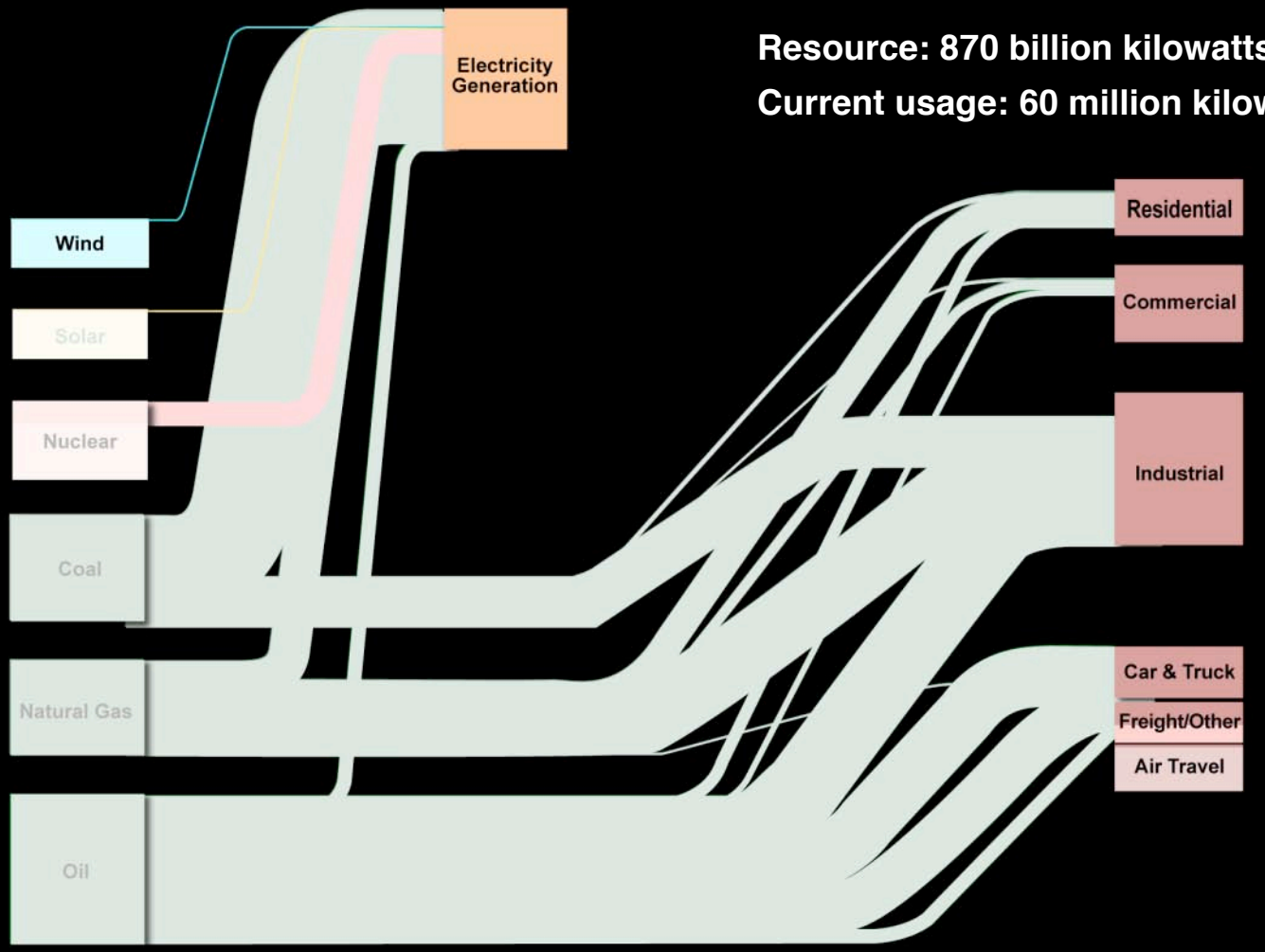
High solar cost, day/night and seasonal patterns make solar power least used source

Resource: 25 trillion kilowatts (on land)

Current usage: 1 million kilowatts



Our Use of Wind Power has Grown Dramatically As Costs Came Down in the Last 10 Years



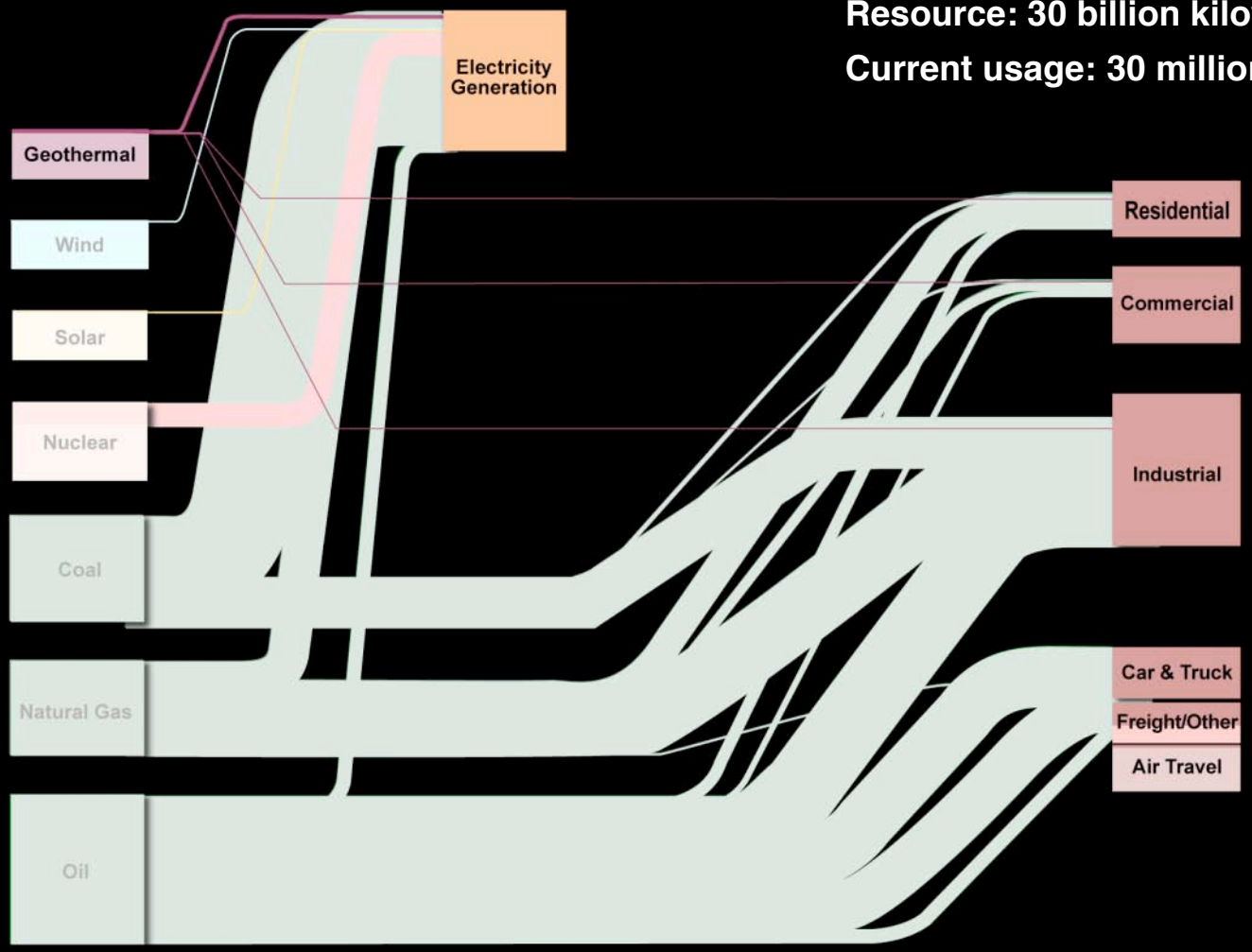
Resource: 870 billion kilowatts (all winds)

Current usage: 60 million kilowatts

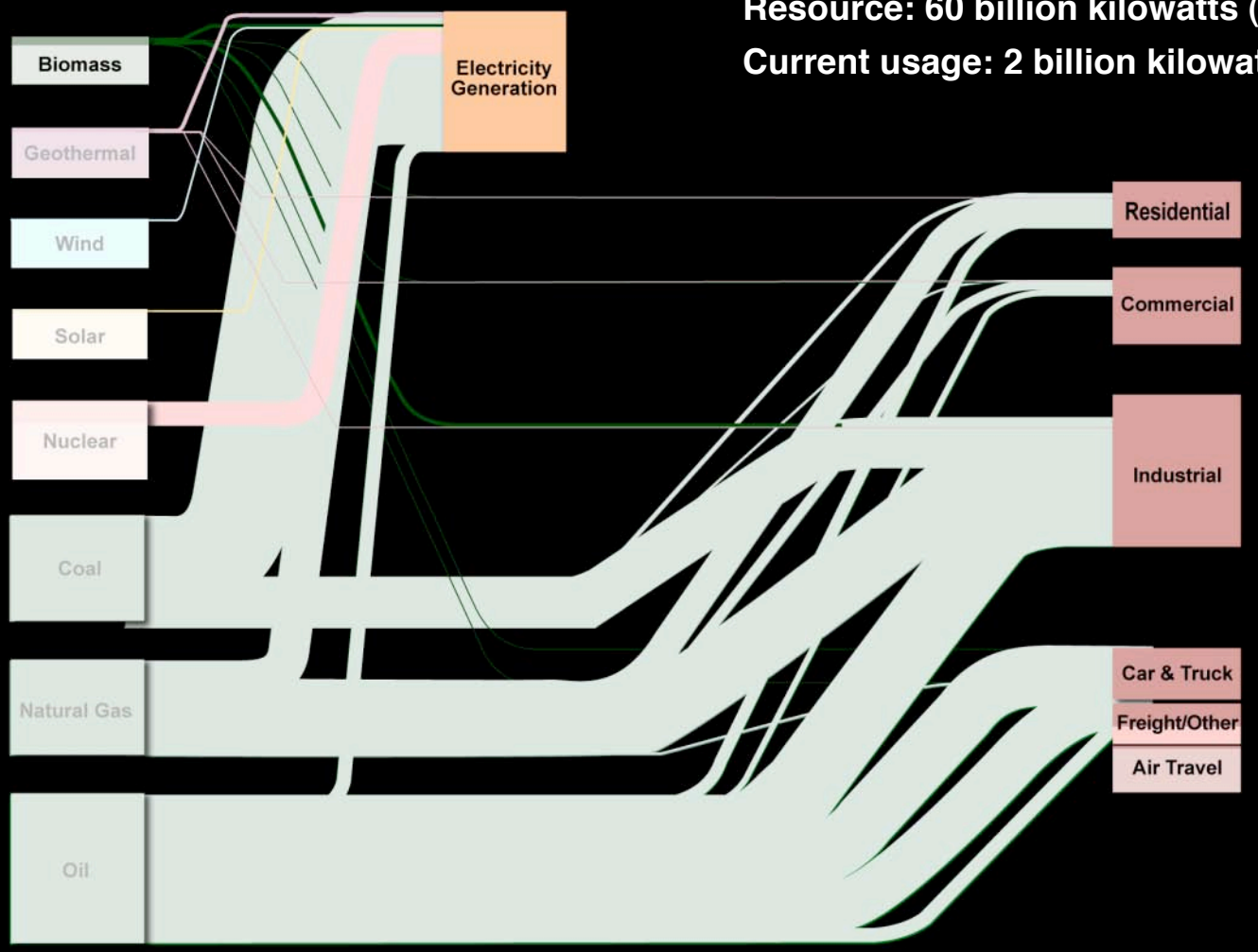
Geothermal power plants have made cheap electricity for decades, but potential is limited

Resource: 30 billion kilowatts

Current usage: 30 million kilowatts



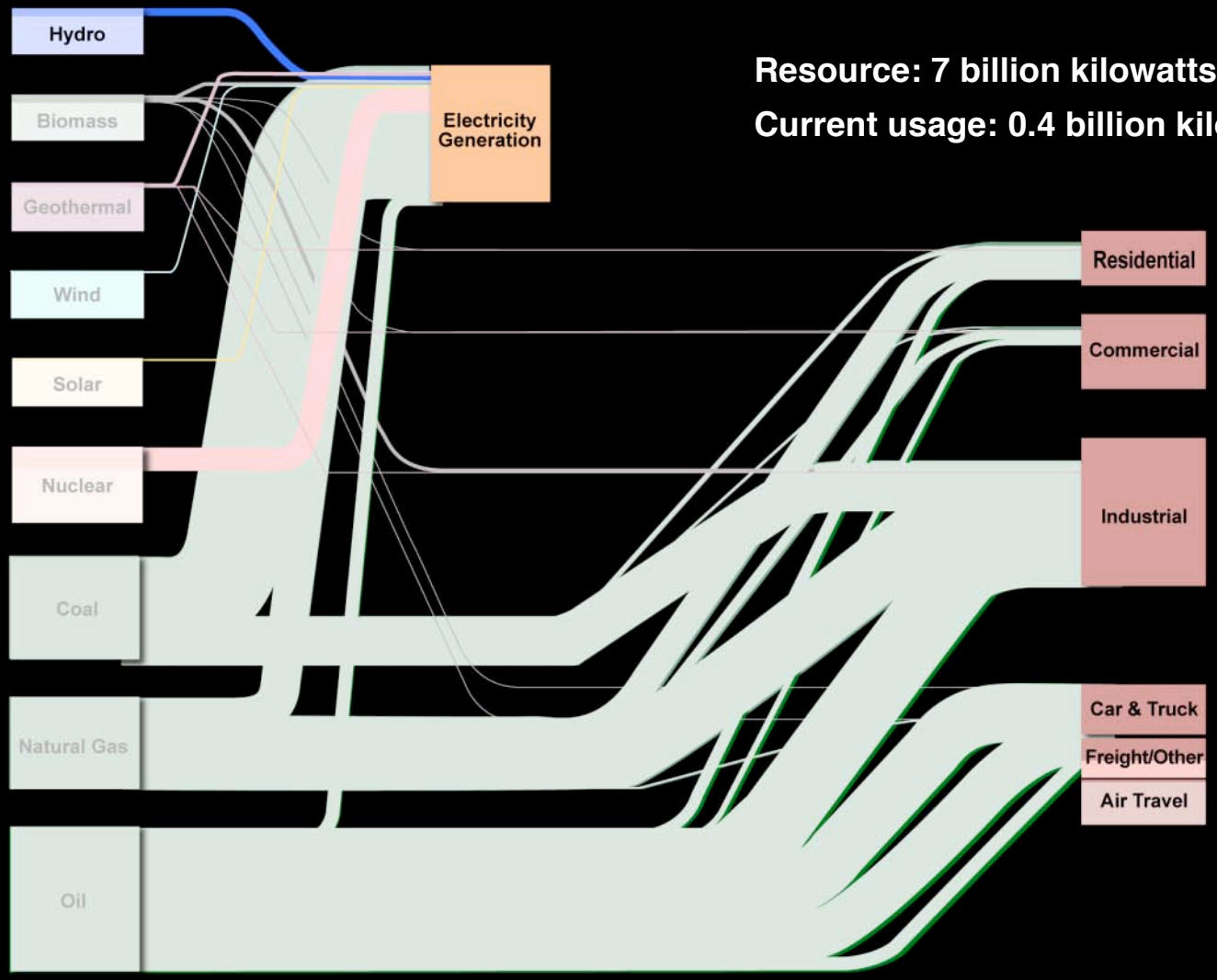
Biomass provides energy for heating and electricity, especially in developing countries



Resource: 60 billion kilowatts (land)

Current usage: 2 billion kilowatts

Hydropower provides 18% of our electricity, inexpensively and without fossil fuels



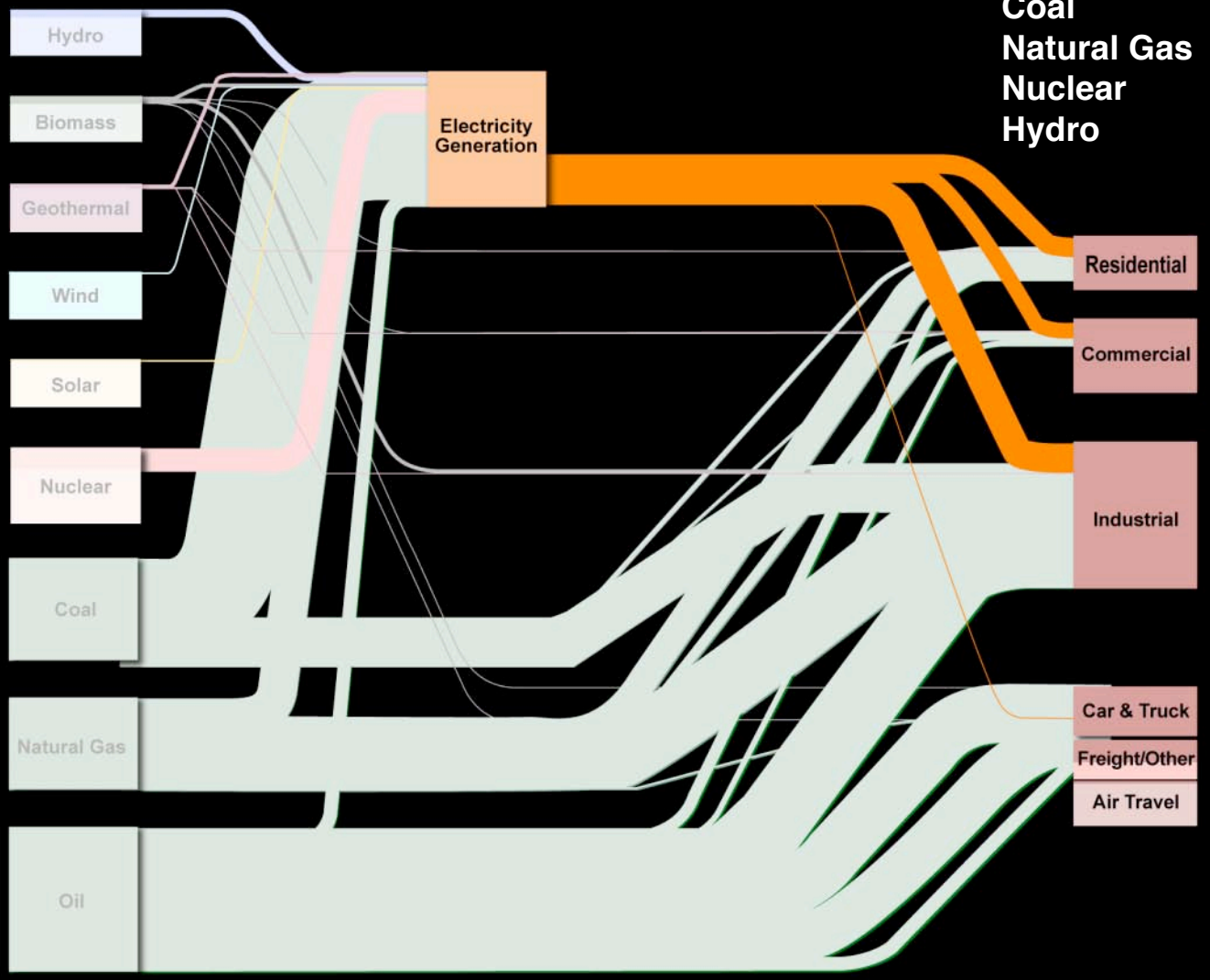
Resource: 7 billion kilowatts (major rivers)

Current usage: 0.4 billion kilowatts

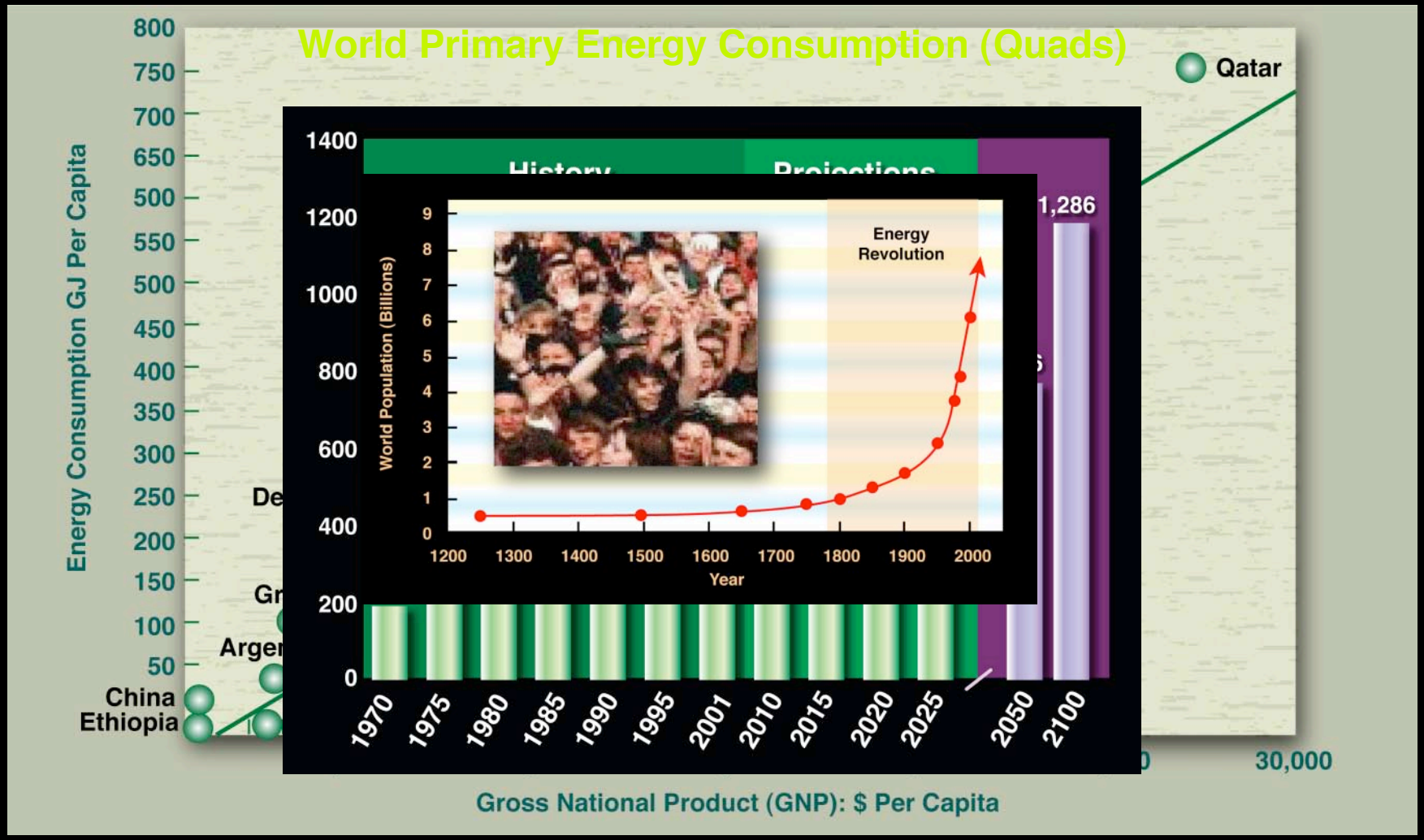
We use Enough Electricity to Move the World's Cars and SUV's

Many Different Sources:

Coal	41%
Natural Gas	17%
Nuclear	16%
Hydro	18%



Future world energy use is dependent on standard of living and population growth



Is There An Energy Crisis?

How much do we have?

How fast are we using it?

When are we going to run out?

What about the environmental impacts?

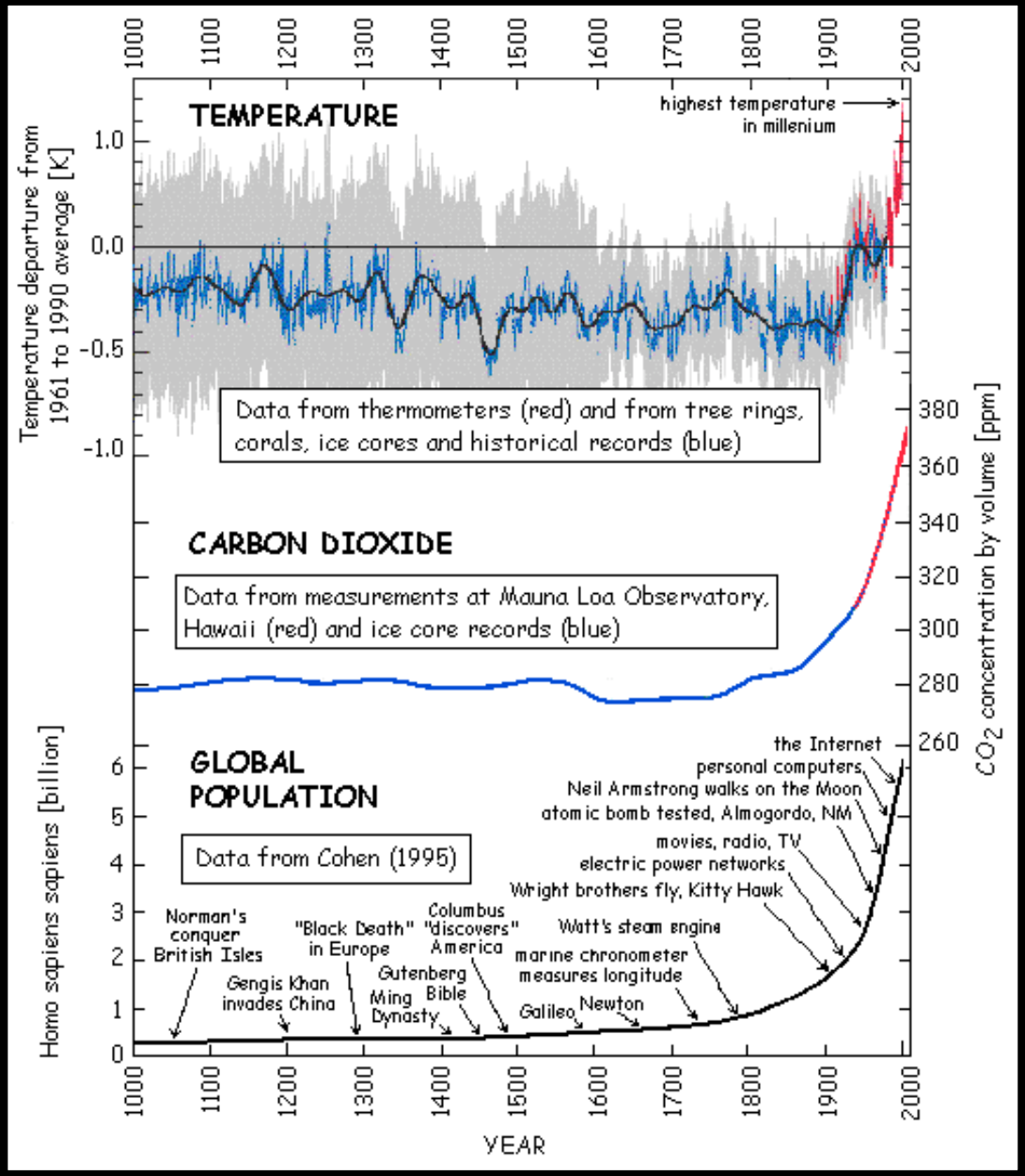


Figure from Marty Hoffert, NYU

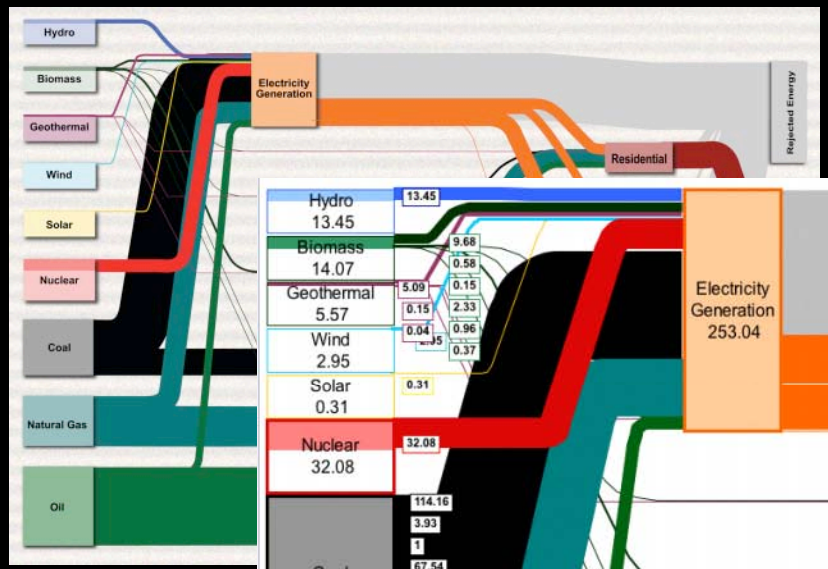
Most scientists now agree that global warming is real

And that we have changed the world's climate by our energy conversion activities

Problem: burning fossil fuels

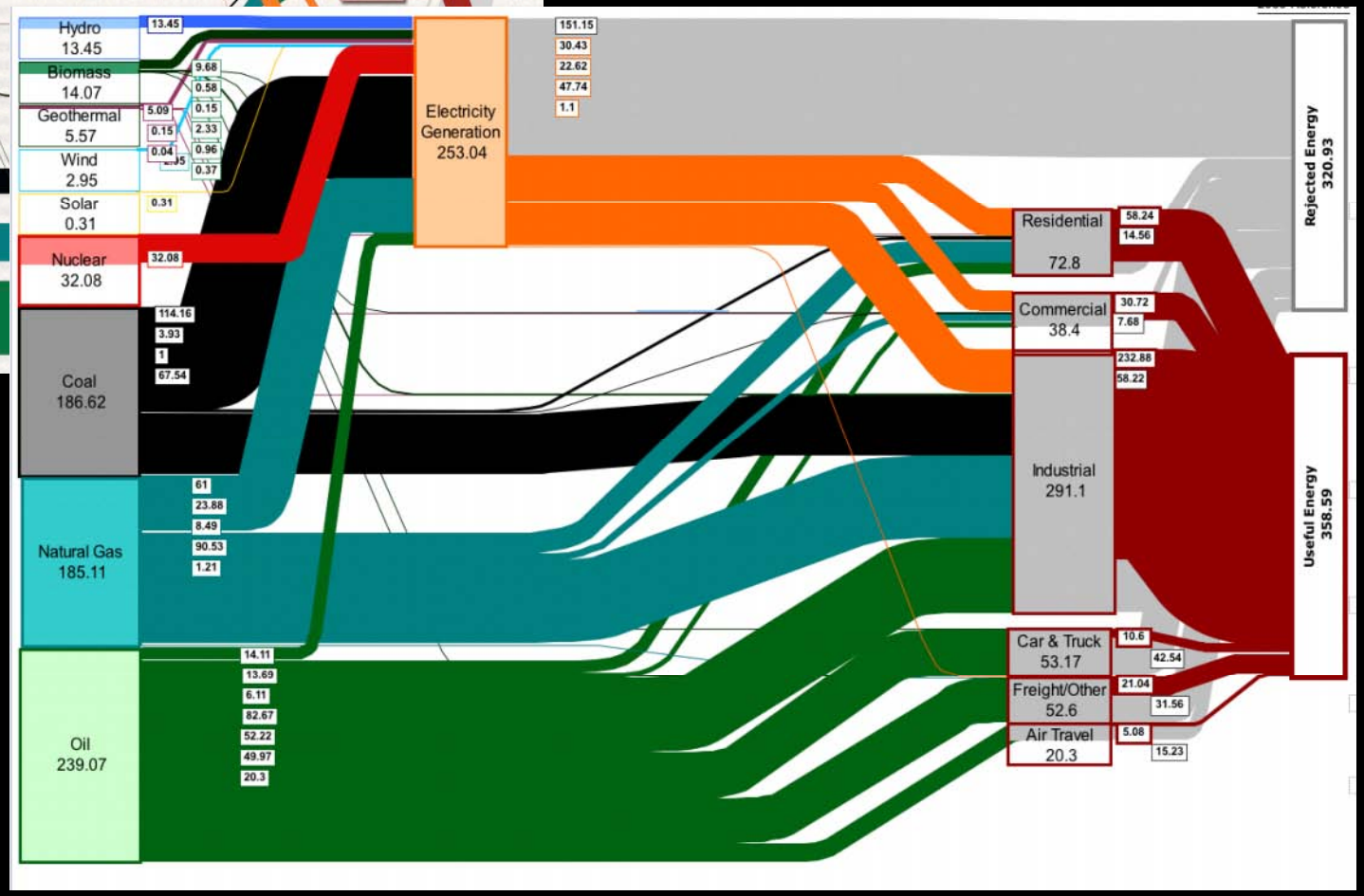
World energy & greenhouse gases like CO_2 will increase dramatically by 2030

Today



Massive **CO_2 emissions**

2030

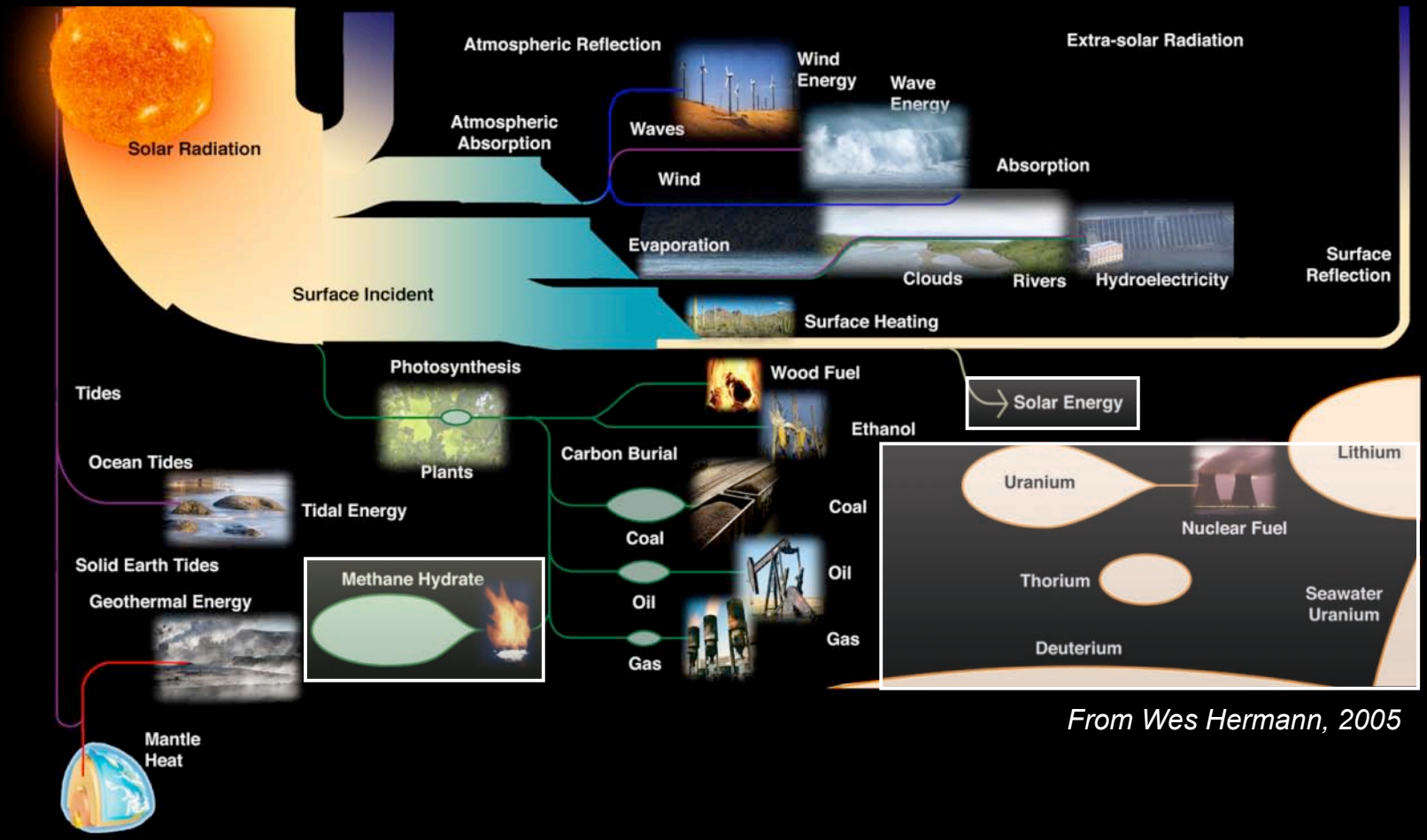


Is There An Energy Crisis?

What do you think?

Can Technology Save Us?

What can we do?



From Wes Hermann, 2005

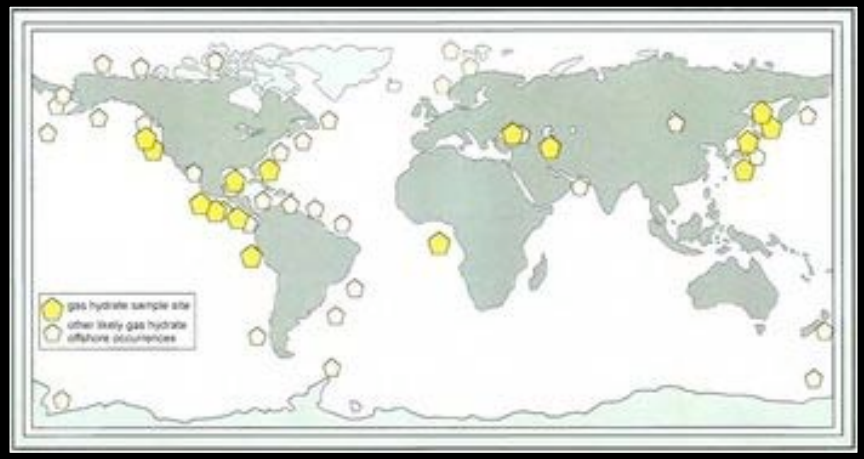
Three ways to go: get more fossil fuels, harness the sun, and more nuclear energy

Get More Fossil Fuels (for now)

"Oil Shale"

U.S. has 90%

1.6 trillion barrels

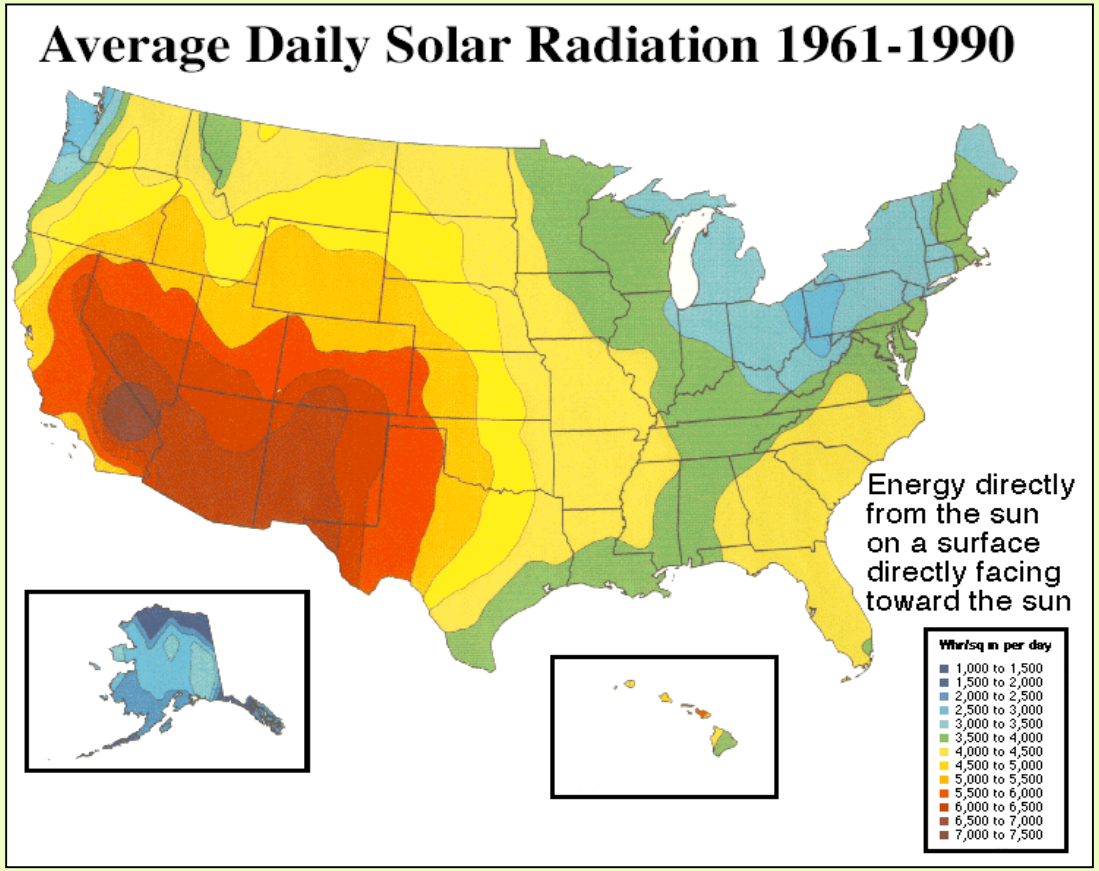


Methane hydrates

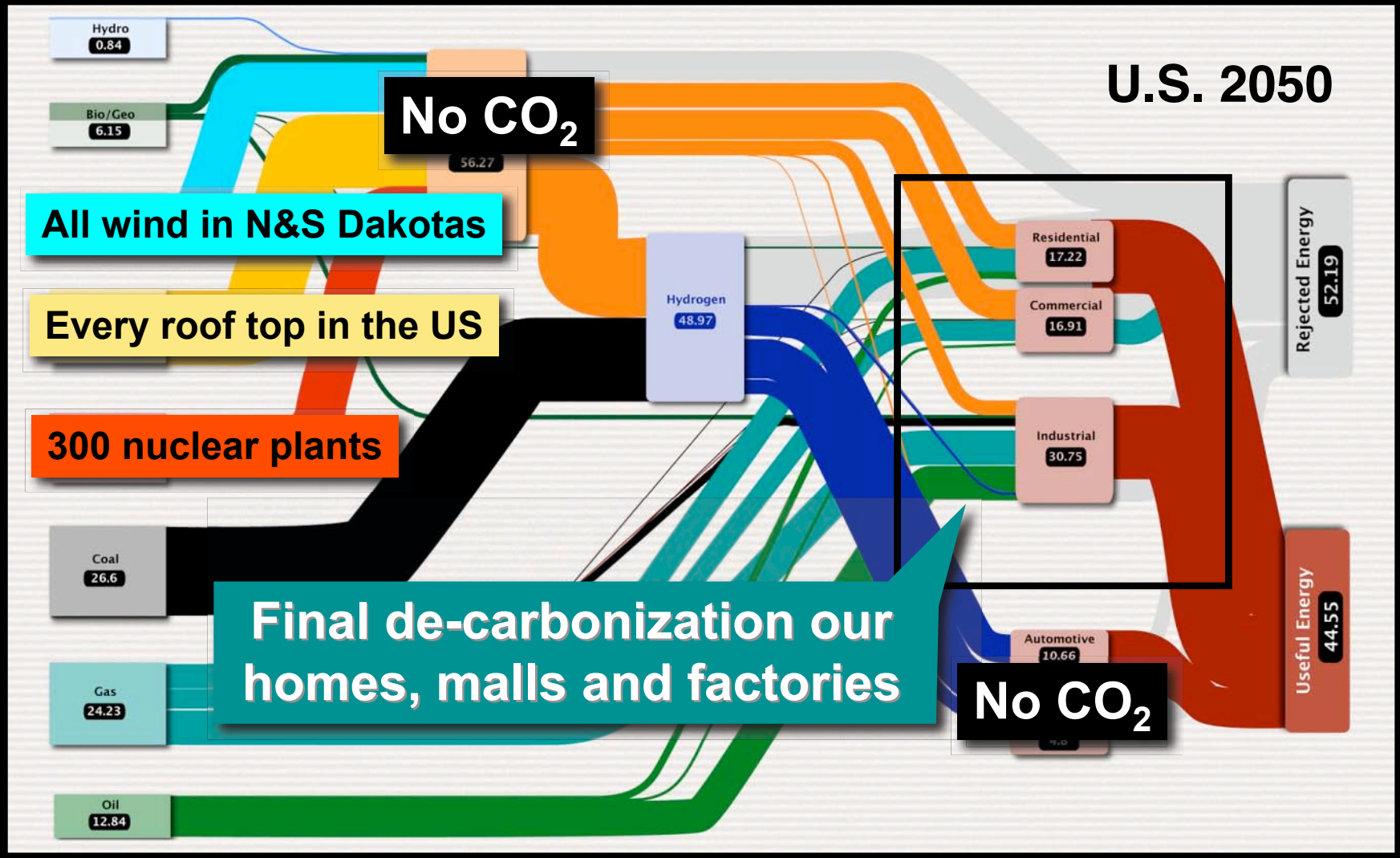
(Twice all other fossil fuels)

Use More Solar Energy

Cheaper solar, more wind, and efficient biofuels



Nuclear, Solar and Wind for electricity and hydrogen cars trucks and planes



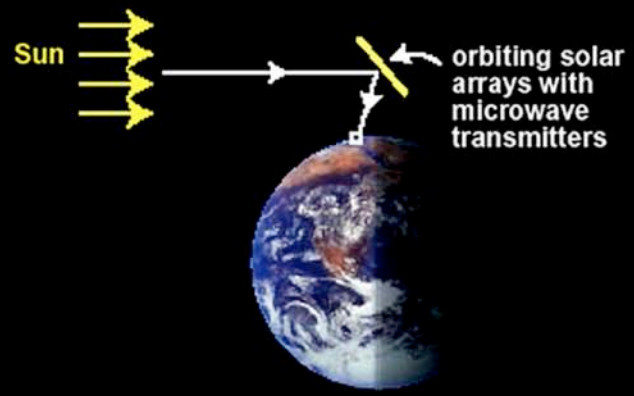
14,000 pounds of CO_2 for every American, each year!

Energy from outside our world

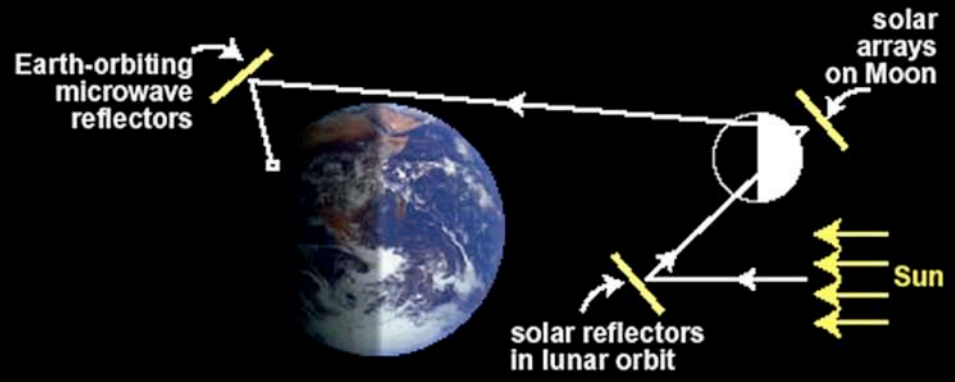
Convert Sunlight to Power then Beam it From Space

(Peter Glaser et al., 1970s)

Generation of power in-orbit, transmission to Earth by microwave

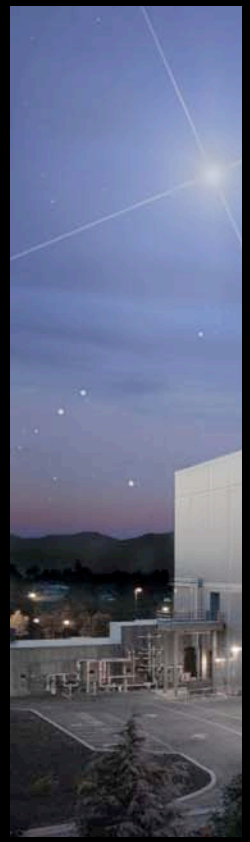


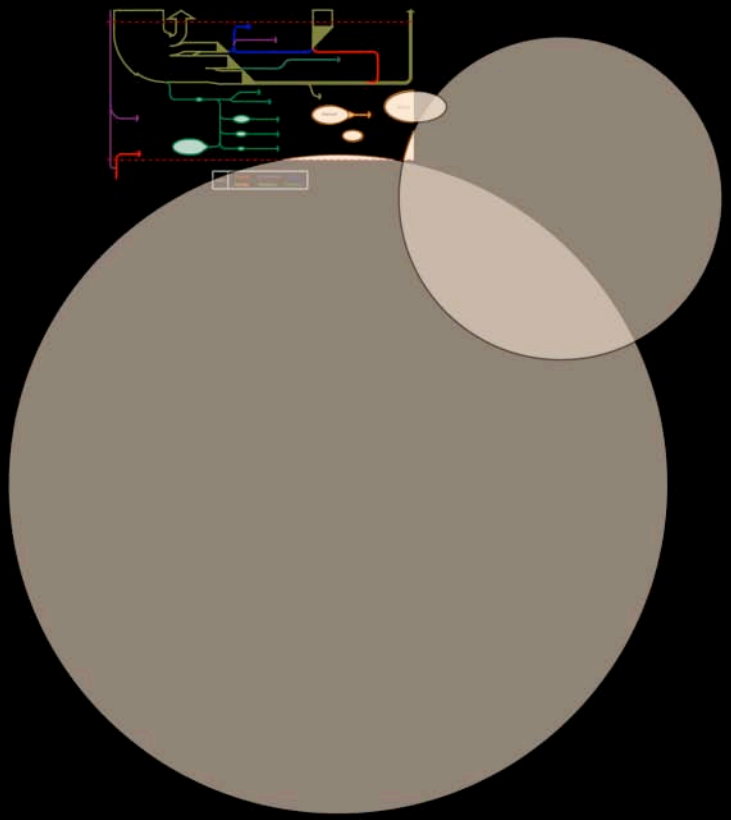
Generation of power on the Moon, transmission to Earth by microwave beams

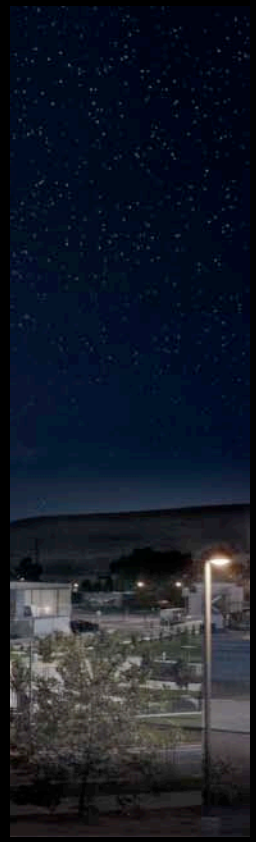


Energy from Windmills floating in the sky (sending electricity 20,000 feet down)

Fusion: a sun on the earth

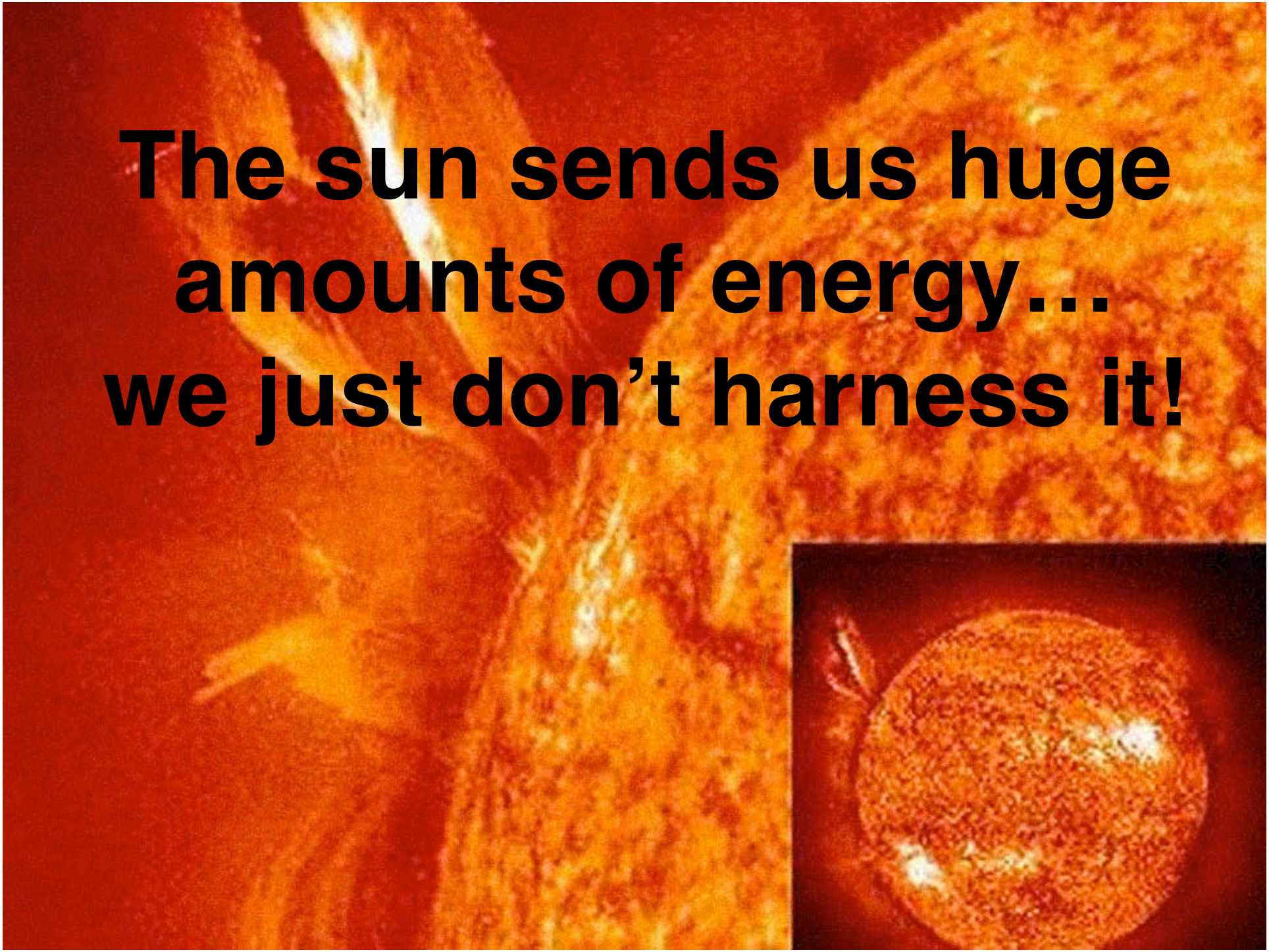






Unlimited energy from water!

What did we learn?

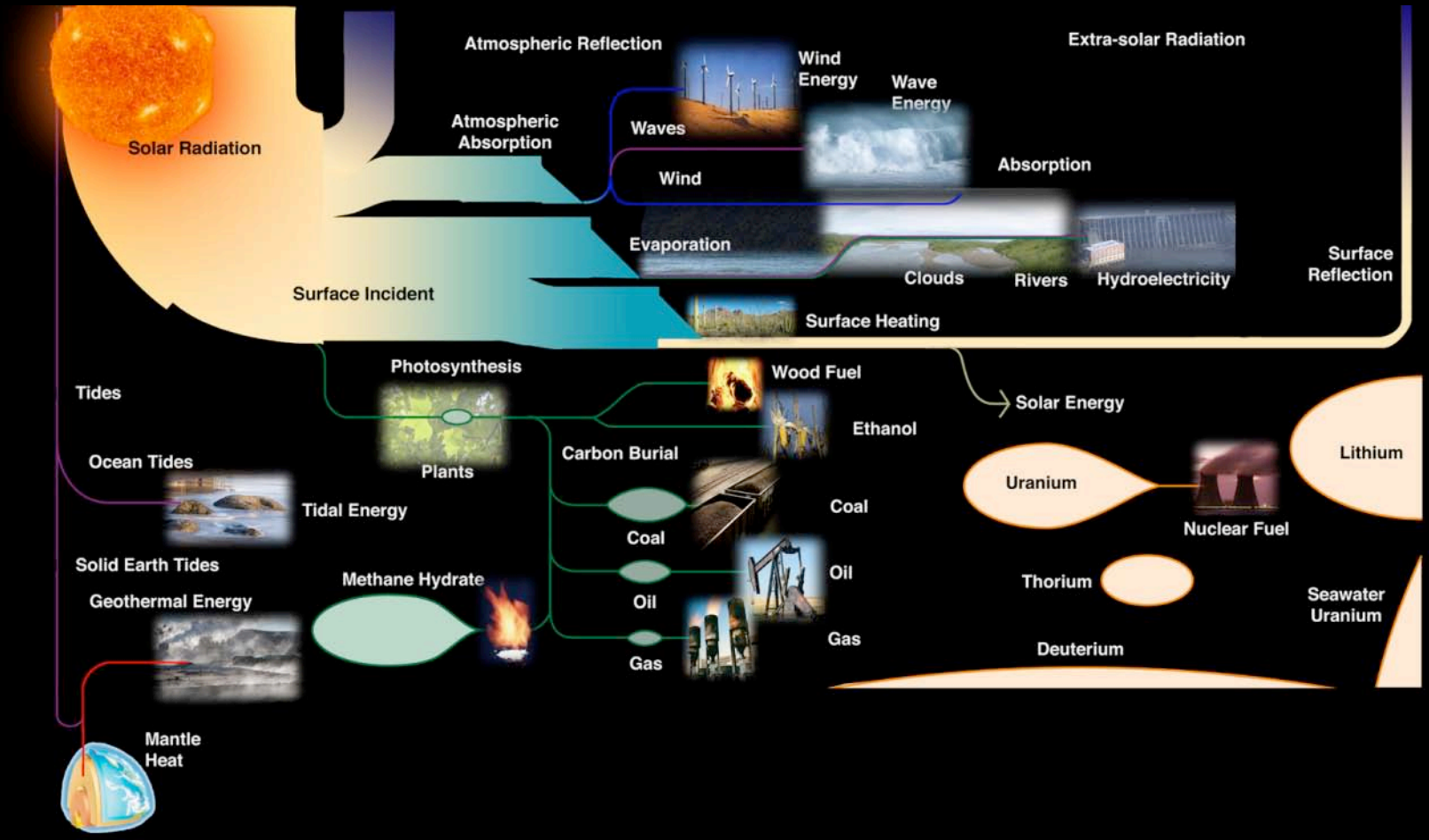

The sun sends us huge amounts of energy…
we just don’t harness it!

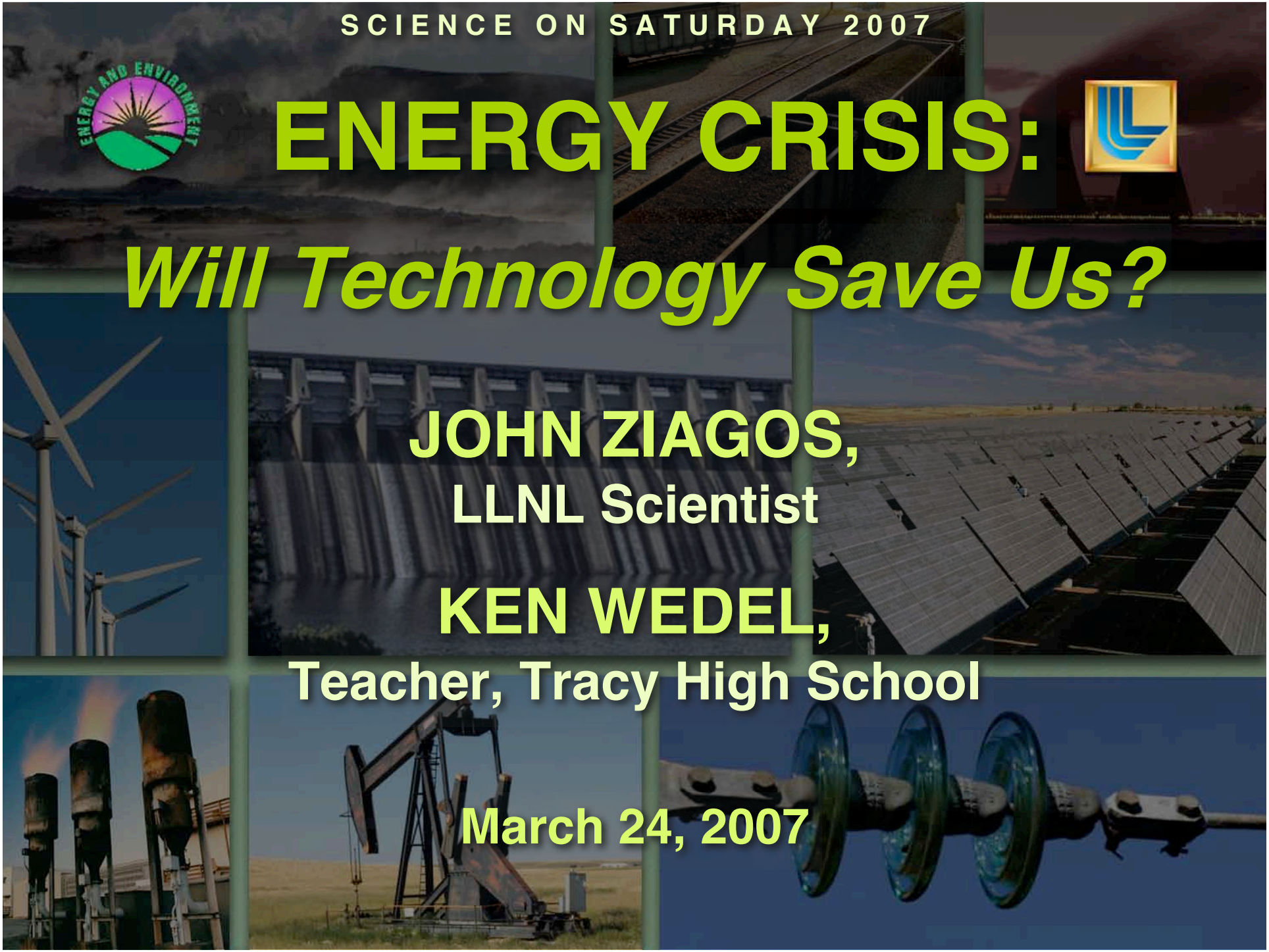

Today, most of the
energy we use is
from fossil fuels

The future: we will need new technology ideas for harnessing nuclear and solar power

The challenge is yours!

Our future will depend on many technologies and energy sources

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